

# A New View: Creating Tools to Access, Conserve, and Understand Visual Cultural Heritage

Interview with Robert Erdmann,  
Rijksmuseum and University of Amsterdam

LISBET TARP

*I takt med at den teknologiske udvikling giver nye muligheder for at registrere og dokumentere kulturarven, stiger den mængde af information, som potentielt set kan benyttes i ræsonnerede kataloger og værkdatabaser. Værker bliver fotograferet digitalt i meget høje opløsninger, og man kan indhente information om værkernes materielle komponenter og tilstande ved hjælp af tekniske optagelser med bl.a. bølgelængder som ultraviolet og infrarød. I arbejdet med kulturarven får konservatoren og kunsthistorikeren således i stigende grad hjælp af naturvidenskabelige undersøgelser og computerbehandling, hvilket fordrer tværfaglige samarbejder. I dette interview præsenterer Robert Erdmann fra Rijksmuseet i Amsterdam og professor ved Amsterdam Universitet sine overvejelser og metoder i forbindelse med at udvikle digitale redskaber, som kan understøtte den visuelle analyse, vidensproduktion og -deling i kulturarvsforskningen.*

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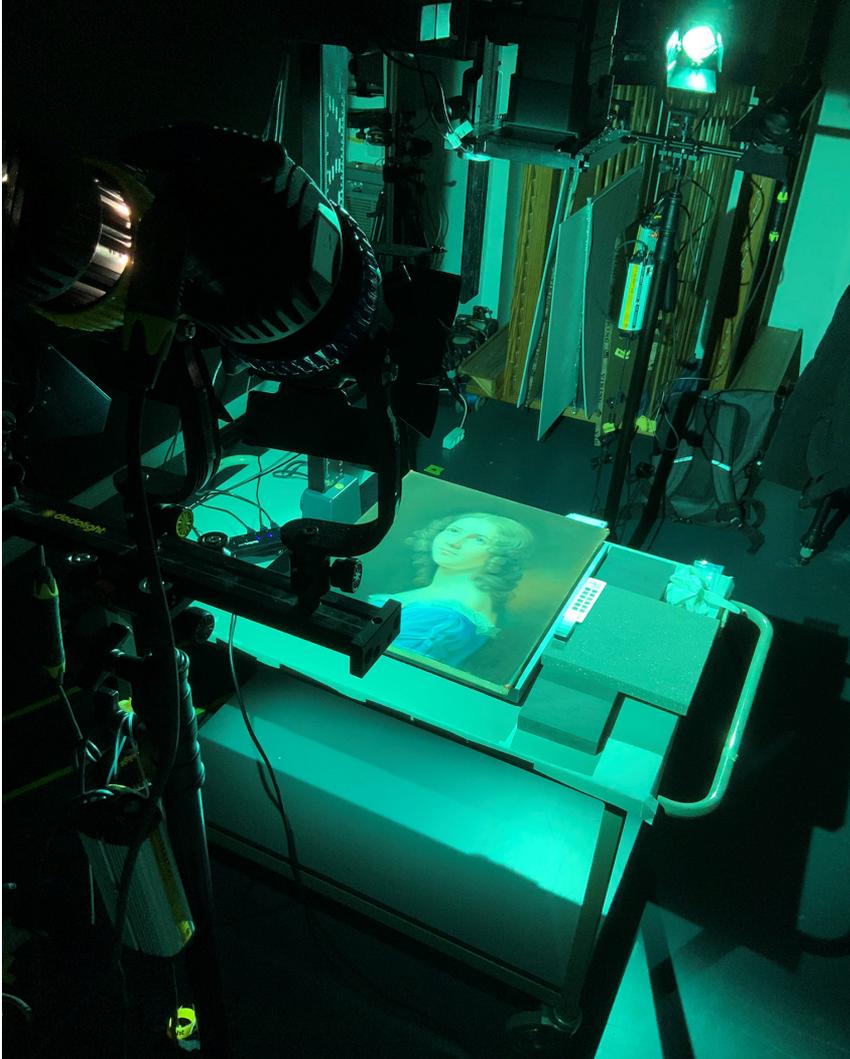
LT: Working at SMK – The National Gallery in Denmark, I realized the importance of fostering multi-disciplinary teams of natural scientists, art historians, and conservators. How does your training as a materials scientist influence your way of thinking about cultural heritage work?

RE: The basic world view of a materials scientist is that you want to understand the properties of a material and how they relate to its structure and its processing. Property is defined as the way the material responds to stimuli. How it is *processed* and how its *structure* is then changed. Every time you perform processing, whether grinding up pigments and mixing

them with linseed oil, or taking a canvas and stretching or priming it (these are all processing steps), you change the structure on one or more scales. When you change the structure, you change the properties. By looking at structure, you can infer details of processing. For instance, if I'm studying a Rembrandt painting, I want to know how Rembrandt painted it. I want to know what layers of paint are here. I want to know if it was painted by Rembrandt or one of his pupils, or if it is a product of a restoration. Is it a repair from the acid attack of 1991? Was it punched? Rolled up and stored in a cave during ww2? These actions can be described as processing, so they leave behind evidence in the structure of the material. Today, we can use various imaging techniques that look at properties to understand the artworks in a broader scope. Looking into what an object has been through allows us to describe its biography.

LT: The Rijksmuseum in Amsterdam is one of the museums that has been leading the way in the digital realm. It is at the forefront of making its collection digitized and online, free for use. What motivates you as a computer scientist at a museum?

RE: Broadly, I have a mission, and that mission is to help the world access, preserve and understand its visual cultural heritage. Any kind of work that goes towards that goal is fair game. I am trying not to pigeonhole myself. I usually work with images of artworks. These images might be regular photos with visible light or technical images like x-rays or MA-XRF scans that can tell us the elemental composition across the painting at 100 million locations. Or multiband images made with different wavelengths like UV-lights (Ill. 1). High-resolution images are often made up of a grid of photos that are stitched together afterwards. This means we need to aim to automate the entire process of capturing images to ensure that the colors are not messed up, that the image is not being weirdly warped or, for instance, that one of the photos is not slightly lighter than the others because your lights weren't perfect and so on. 90% of the work I do is behind-the-scenes work in developing the system of software that can take a pile of images of a work of art – optical photographs, x-rays or some chemical scans – and figure out how they align and remove all the artefacts from the imaging, for example, if they are out of focus or differently lit on one side than the other, or if they have lens distortion. All of this may not be glamorous



ILL. 1

Capturing technical images of a pastel by Christian Hornemann (1765-1844). Photo from a workshop in November 2020 at SMK – *The National Gallery in Denmark*, with *Phase One Photo* organized by Lisbet Tarp and funded by her project *Digital Art History: Rediscovering the Painting*, The Independent Research Fund Denmark. Photo by Lisbet Tarp.

or interesting to an art historian. But it is necessary if you want a stack of images that are all very precisely co-registered. If you put your finger on one point on the artwork, you want to know with confidence what each of the imaging techniques has to say about this point.

LT: How do you face the challenge that the technology allows for an increasing number of images and kinds of images that are collected in relation to artworks?

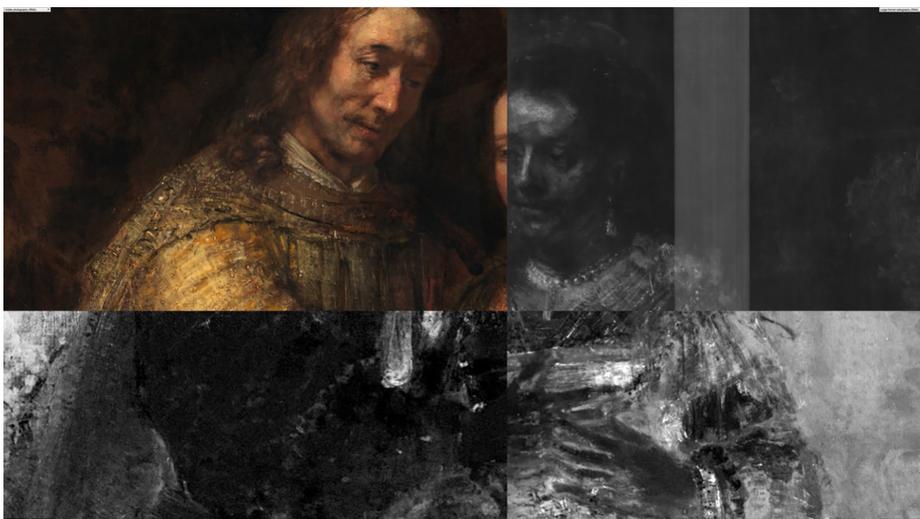
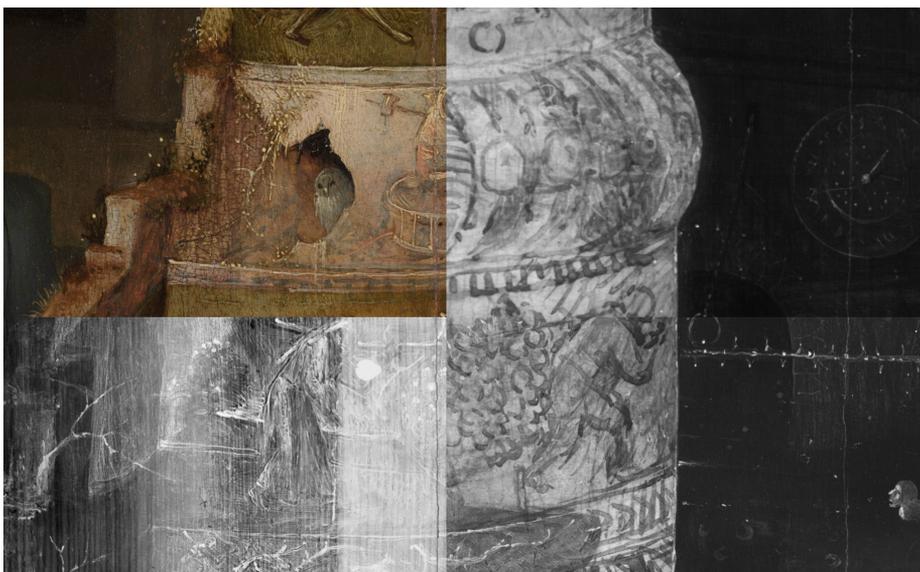
RE: In the past, we suffered from drought of data. If you wanted a high-resolution image of a painting, you couldn't get it. Even the ones you paid for from a museum were not really of a high enough resolution to see brush strokes and retouches and these kinds of things. So we have quickly gone from that era to one where we have a deluge of data. For example, three weeks ago, I finished a 717 gigapixel image of Rembrandt's *The Nightwatch*.<sup>1</sup> It is almost 1 million pixels wide, and it is more than 700,000 pixels tall. It has five micrometer resolution pixels. To give you a sense: A human blood cell is eight micrometers wide. Besides, we captured a wide range of technical images. This means that we are completely inundated with data, and, to have any hope of making this useful, we need to have a fairly heavy infrastructure and very sophisticated behind-the-scenes ways of fusing all of this together.

LT: In your position as a senior researcher, you develop tools to interact with, analyze, and communicate the vast amount of material produced in relation to the documentation of cultural heritage. How is the process of making such tools?

RE: The part of my work that is visible are the tools that I think you have in mind. And they are part of developing ways to access, preserve and understand this pile of data. This process can follow a number of different paths. Broadly, I identify *a need* or *a possibility*.

Possibilities can be found in considering existing tools, for instance, tools used in weathercasts or in medicine, where you can take the technique and simply cross it over and utilize it in the cultural field.

To take another kind of example, where I identify a need or a friction: I was one of the six researchers on the Bosch Research and Conservation project.<sup>2</sup> We went to all of the museums in the world that had Bosch paintings and drawings and collected high-resolution images with our imaging equipment. In that connection, I made a so-called *Curtain Viewer* and what I have named *Morelli's Vision tool* based on the insight I gained watching art historians work (Ill. 2 + 3). These art historians would go into a conference room with a huge table and a stack of books, mostly about Bosch. They would make points and then repeatedly riffle through the books and find the pages, compare and elaborate their arguments. This struck me as really frustrating and not at all reproducible. It was confined



**ILL. 2 A+B**

The Curtain Viewer. In this viewer, a number of different technical images are combined on top of each other. By moving the cursor, invisible features captured in the technical images become visible, for instance, underdrawings or changes in the composition.

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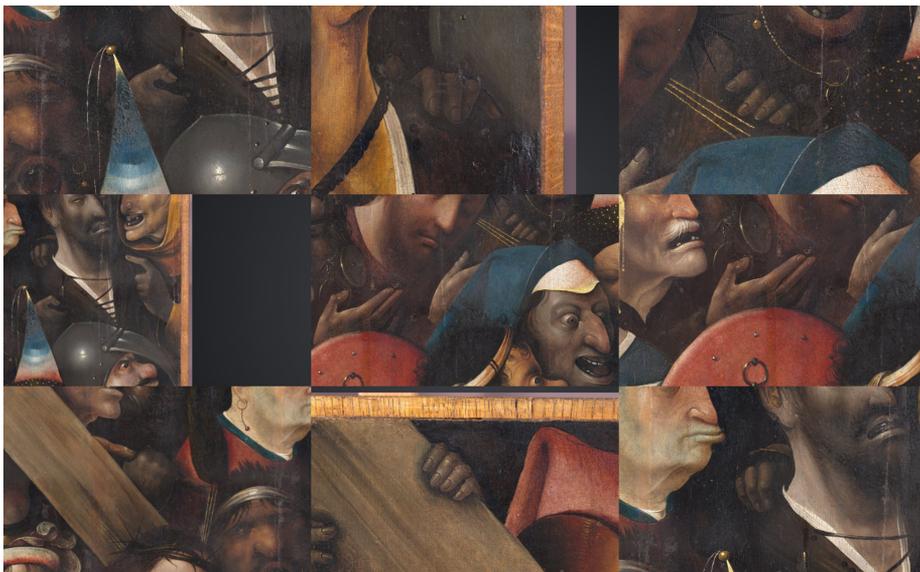
ILL. 3

*Morelli's Vision tool* was developed as part of The Bosch Research and Conservation Project, 2013:

<http://boschproject.org> (accessed 10 September 2021)

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to this conference room and it required you to have all these books. It was always frustrating with these books; you had these little postage stamp-sized images, and the color management was terrible. When you saw color differences between images in two different books you wouldn't know if the color management was really bad or if the paintings were actually different. In this way, identifying a friction or a frustration in watching other people do their work is an opportunity to think about how to make a tool to assist the process. One of the founders of the method of connoisseurship, Giovanni Morelli (1816-1891), was interested in the close examination of details like earlobes or fingernails. Like a detective, the educated eye would trace important information in the details about the process of making and the identity of the maker. If Morelli had come up with this idea today, what tool would he want? This question led me to develop what I call *Morelli's Vision tool*. Basically, the tool gives you the ability to organize, for instance,



**ILL. 4**  
*Morelli's Vision tool.* Zoom out from selected details.  
 Image reproduced with permission of Robert Erdmann.

all the hands that appear in Bosch's paintings. When you click on a hand, a computer vision algorithm will reorganize all the hands according to the stylistic similarities to the hand that you have clicked on and select a subset of hands. You can see all the images side by side in a viewer in which they are not disembodied, meaning that you can zoom out (Ill. 4). The disembodiment of illustrations in art history publications is another example of friction. If you see a beautiful detail shown in an article, you cannot zoom out and see the body the hand is attached to and compare it with other hands in the picture. Is the chosen detail cherry-picked to make a point?

**LT:** In this respect, you put your finger on a soft spot in the methodology: the reproducibility and documentation of perceptual comprehension. Do you have any further reflections on this issue?

**RE:** When I first joined the Bosch project, I didn't really know Bosch. I was asked to do it because I was good with images. One of the art histo-

rians on the project had already gathered a lot of works by Bosch, works by Bosch followers and, according to him, works clearly not by Bosch. He laid them out on the table in these groups, and the conversation started something like: "...so you can see clearly that these all belong together. These ones are not Bosch, and the group here, it is a joke. I can't imagine that anyone ever said that they were Bosch." And I really tried hard to see it, but I couldn't see it. I consider myself someone who is good at looking, but I did not see the difference at all. He is a connoisseur. He studied Bosch for years and years, and I did not. So I said this is exciting, please teach me how to see this. And he couldn't. He said: if you can't see it, where do I even start. He was very kind, but he treated me as if I was blind: If you are not going to open your eyes then how can we even have this conversation? But interestingly, now that I have spent so many thousands of hours working with Bosch, I totally agree with him. I absolutely agree that certain works belong together and that others are totally different.

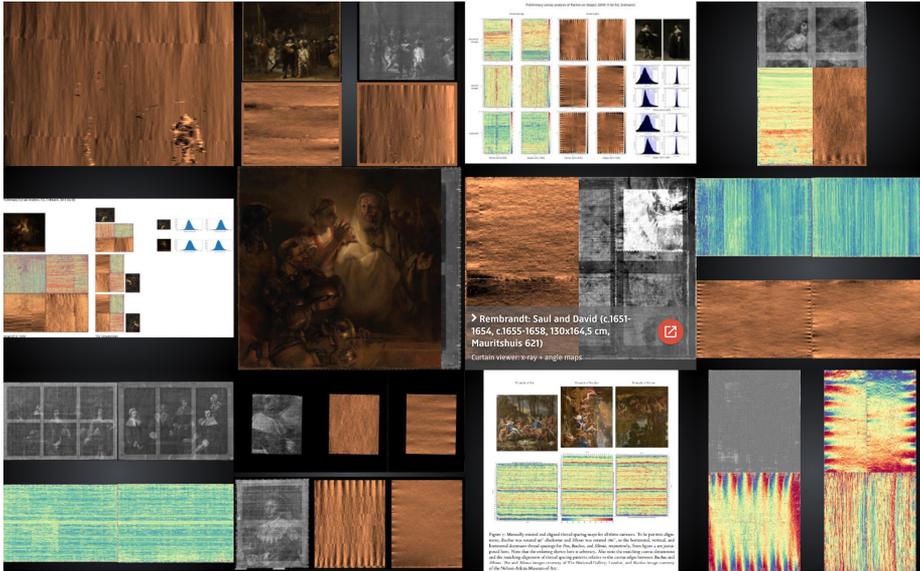
I believe in connoisseurship. I understand the value of spending a lot of time in front of these works. And I don't think that a computer is going to replace that. But still, one of the things that inspired me in the Bosch project was a desire to make tools for this art historian so he could show me what he meant: It is excellent that you can see a difference, document it for me, show me side-by-side. Show me the "yes, definitely", show me the "definitely not", show me the ones in between. This is teaching by example rather than wordy descriptions like *loose and open style*. What do you mean by that, really? For those few who perhaps have a shared vocabulary for and a shared experience of discussing these works, those kinds of phrases might mean something. But, as an outsider, I was not able to participate in the conversation, because I didn't understand what differences were relevant and what differences were not. Because that is another key bit. The connoisseur will zoom in on particular aspects and ignore differences that are not relevant somehow. So an untrained eye will just zoom in on obvious differences and then not understand why this group that are all obviously different should be separate from this other group. Because the connoisseur has a way of looking that is different. The tools that I develop can play a role, I think, in helping the connoisseur to say and to show what they mean.

LT: How have your tools been received?

RE: In terms of the reception of the tools, it has generally been very positive, but there is a kind of old guard that look upon them with great skepticism. In some cases, this just reflects a discomfort with technology or a feeling that it is not necessary because we already have a way of doing things. At the same time, the tools to help the art historian are challenging the traditional authority of the person who could just *sniff the Rembrandt*, because when a tool comes along, it may have the ability to disprove them. There is definitely a generational shift. The up-and-coming generation of art historians are very comfortable with the technology and excited about the possibilities to understand the truth better through these tools. Cross-collaboration is important and the thing that really interests me. For instance, I am currently collaborating with art historian Anna Tummers on the project *21st Century Connoisseurship: Developing Smart Tools for the Analysis of Seventeenth-Century Paintings*.<sup>3</sup>

LT: How does getting a response to your tools play a part in your work?

RE: One of my PhD advisers had a piece of advice that I thought was good and I often followed it. He said: you have to make a *table thumper*. If you have an idea, you can tell people about the idea. You can make a document describing it and so on. But it will be dramatically less effective than if you make a simple prototype. If you speak about a tool in a very abstract way, every person in the room has their own vision of what you really mean by it. The ability to make decisions about it and the ability to get excited about it is hindered. Often people will want to polish a design until it is perfect before they introduce it to the world. I follow the exactly opposite strategy. Instead, I will make something crude that has its guts hanging out. This is also why I chose to be half in a museum – because, when I have an idea and I make a table thumper, I want it to immediately be in the hands of the people who will use it. In this way, I can give it to them, and I can explain to them how it works. I have great colleagues here at the museum who are delighted to use something that is new or possibly innovative even if it is a pain to use and even if it is not pretty. Then, I watch them use it. I observe frictions they experience using it. As a software developer making tools for art historians and conservators, I also insist that I actively use my own tools, so that I can identify the issues, the sharp corners, the sticking

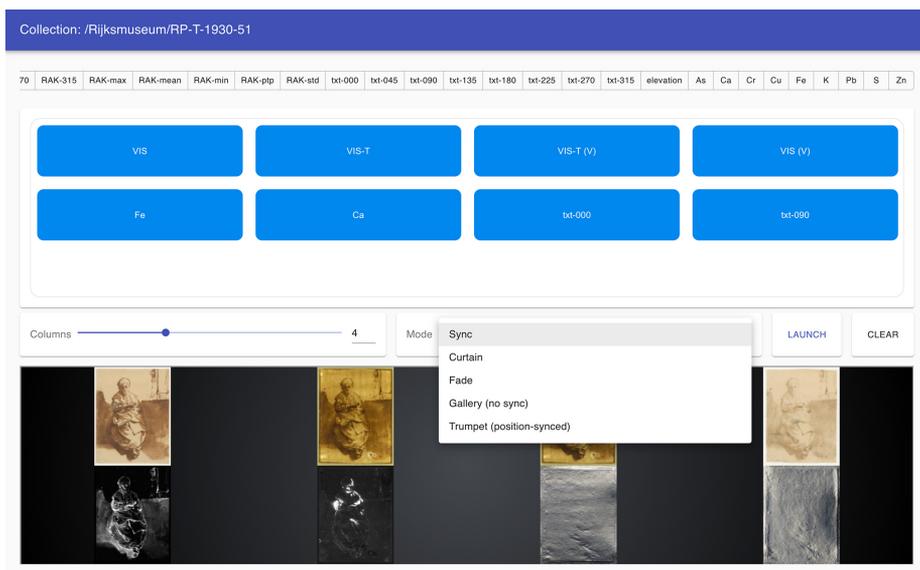


ILL. 5

The tool *Codex digitalis* essentially consists of a Google spreadsheet in which you fill out rows containing URLs with titles of the descriptions; the tool will then process this data and make a live preview. This makes it easier to keep an overview of relevant observations and to share the material. Shown here is a collection of links related to automated canvas analysis. Image reproduced with permission of Robert Erdmann.

points, the misconceptions and frictions, etc. And then I can iterate, the exhaustive process of iteration. This often leads to yet more tools.

As an example, when the Curtain Viewer first came out, you could put images in various configurations. However, there was a friction: getting back to a particular configuration of images was a real pain. How could we store and share these configurations? A modification was needed. The idea was that the URL would change to reflect the exact configurations and views on your screen, if the images were mixed together and so on. This was helpful, but then people started passing around URLs in e-mails. That was nice, but a URL does not show you a preview of the configuration. Furthermore, people would have large collections of URLs that looked very similar. This led to a completely new tool, *Codex Digitalis*, which can make a live preview of your selected URLs (Ill. 5). Using the Curtain Viewer also prompted the need for flexibility in choosing the images to combine.



### ILL. 6

The need for a flexible tool to make new curtain viewers with specific and exchangeable images resulted in *The Draper*, which gives you a menu of all the possible images you can choose and it lets you pick which images you would like to combine, which configurations you want, and how they are ordered.

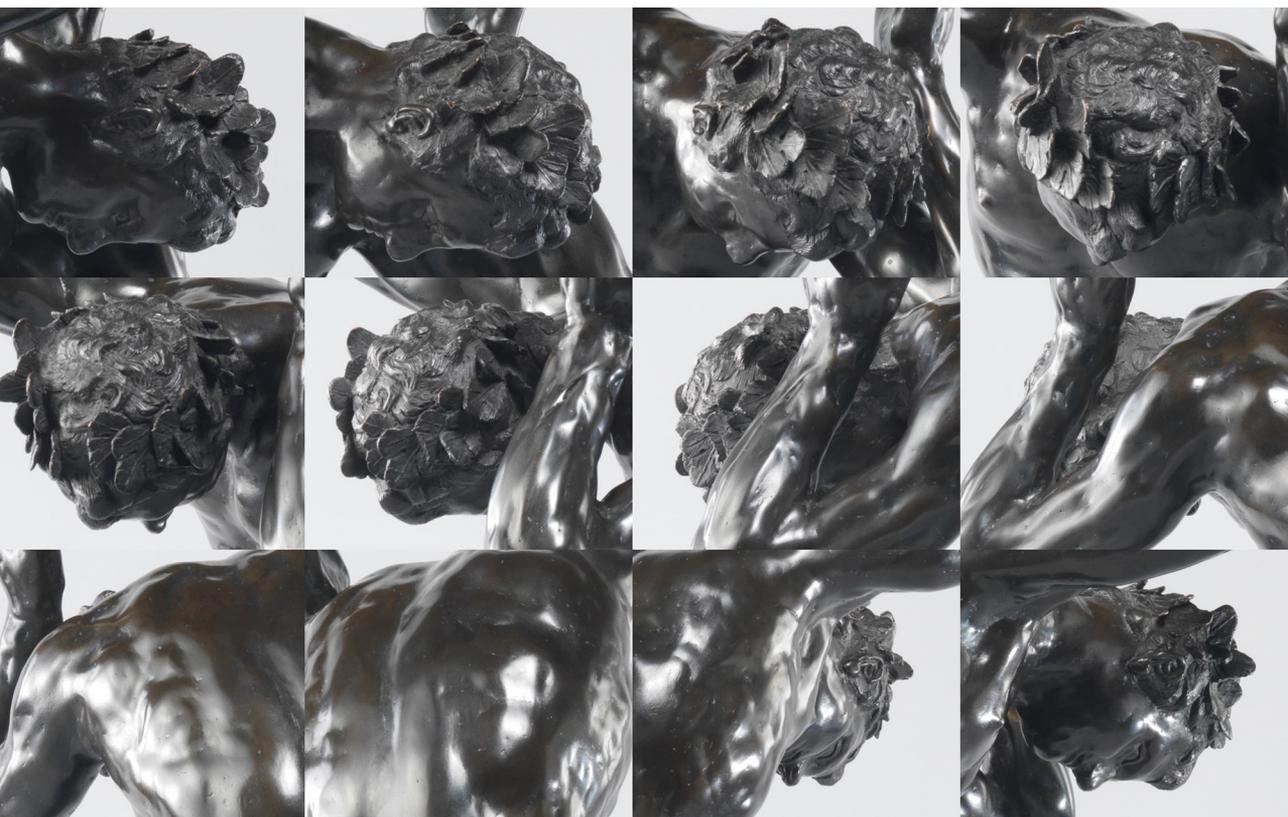
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Finally, this led to a new tool, which was a kind of ‘Curtain Viewer maker’ called *The Draper*. A maker of curtains is a ‘draper’ (Ill. 6). This kind of modular tool led to a lot of new configurations.

LT: Many of your tools are developed in relation to high profile and famous works of art, for instance, works by Rembrandt and Bosch. How do you address and include lesser known artworks and support the work done on them?

RE: I use specific, usually high-profile works to develop, test, and showcase new tools and then the fact that the work is high-profile means that they tend to get exposure. These tools then get put into use behind the scenes for the less high-profile works.

I mostly develop new tools to solve problems that are right in front of me with a specific object or a class of objects. For instance, we had a new purchase at the Rijksmuseum of a Bacchant sculpture by Adriaen de Vries



ILL. 7

An online viewer for *Bacchant*, Adrian de Vries, 1626 (Rijksmuseum BK-2015-2-1). Views from 12 angles are coordinated in real time so that any given feature appears at the center of each view. Image reproduced with permission of Robert Erdmann.

(1556-1626), a very beautiful sculpture. The director of the museum asked me to make this object accessible to the public in a completely new way. So I tried to solve this problem for this one specific sculpture – how to present it in a way that was new and made it feel real and 3D online (Ill. 7). But when I am doing this I am always thinking: if this tool is successful, how will I generalize it? The Curtain Viewer was originally made in service of the Bosch project, but it was abstracted: What is the bigger problem we are trying to solve here? In this case, it was making comparisons among images.

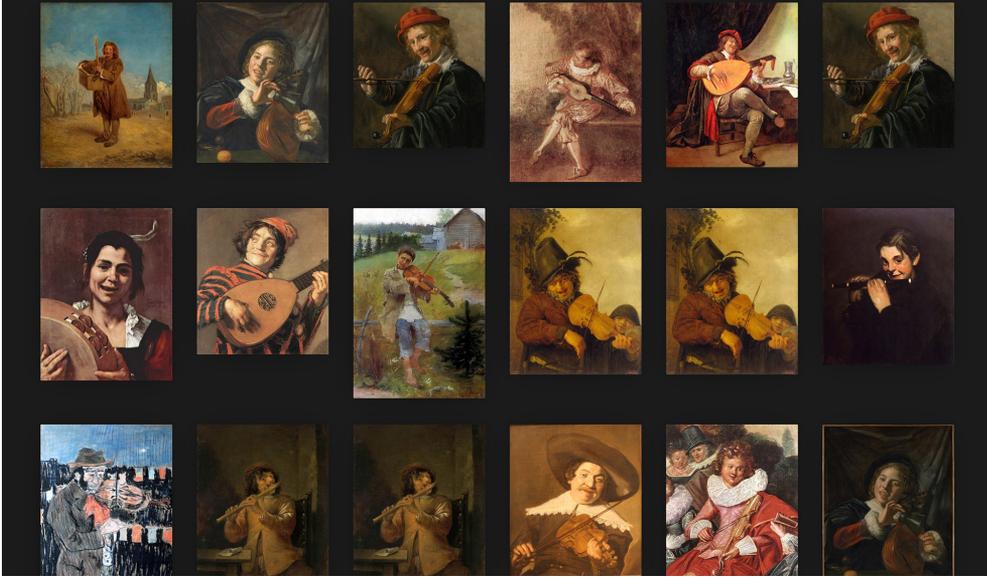


ILL. 8

A zoom-in of a neural-network's automatic arrangement of all the paintings in the collection of the Rijksmuseum, organized by visual motif.  
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LT: What could be interesting to do in the future?

RE: My tools help people zoom in closer on an object; to literally zoom in as well as metaphorically zoom in and understand one particular object more deeply. Furthermore, if you document every aspect of the materiality of an object, you are not leaving behind the iconographic aspect of the object but are broadening the scope of the questions you can ask. How much of what we are seeing is the work of Bosch and how much is the work of the restorers? What fraction of this painting is actual-



### ILL. 9

A new neural network-based search interface for a large collection of cultural heritage images. The interface does not make use of any image metadata; the network is able to associate previously unseen images with English words or phrases so that free-form descriptions can be used to find images regardless of how they may have been labeled.

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ly original? And what did it look like? For instance, the pigment smalt undergoes severe degradation, which, over time, changes the look and expression of a painting. The ability to document and understand the materiality of an object will allow us to have tools like a kind of *time slider* in the future. It will tell you what the object looked like when Rembrandt drew it, what it would have looked like when it was sold at auction 50 years later, and what it will look like in the future, too. Every object is changing. We can't change that. But, in a museum context, we can manage the change, we can slow it, and we can document what it is like. Then, there is zooming out: to put the object in context of an artist, of a particular time period, or the entire collection of the museum (Ill. 8 + 9). If I had the opportunity, I would work more on the zooming out part, but exhibitions form a large part of what drives the work that I do.

*Lisbet Tarp er projektansat lektor i kunsthistorie, Aarhus Universitet, i forbindelse med sit gruppeprojekt Digital Art History: Rediscovering the Painting (2019-2022). Projektet foregår i et samarbejde med SMK – Statens Museum for Kunst. Tarp har tidligere publiceret om materialeforståelse, naturfilosofi, kunstteori og kunsthåndværk i 1500- og 1600-tallet.*

*Robert Erdmann is senior scientist at the Rijksmuseum in Amsterdam and professor at the University of Amsterdam. He has previously worked as a computational materials scientist modeling complex phenomena such as metal solidification before turning to the use of technology in the visual cultural heritage field. He has been involved in several cross-disciplinary research projects, while also developing digital tools for viewing works of art in different and innovative ways.*

*In this interview, Erdmann offers insights into the process of developing these digital tools and reflects on cross-disciplinary ventures and aiding the eyes of connoisseurs and users of culture today and tomorrow.*

#### NOTES

- 1 Operation Night Watch: <http://hyper-resolution.org/Nightwatch> (accessed 10 September 2021)
- 2 The Bosch Research and Conservation Project: <http://boschproject.org> (accessed 10 September 2021)
- 3 Link to short project presentation *21st century connoisseurship*: [www.nicas-research.nl/projects/21st-century-connoisseurship/](http://www.nicas-research.nl/projects/21st-century-connoisseurship/) (accessed 10 September 2021)

